INDOOR AIR QUALITY ASSESSMENT

Weston Public Library
87 School Street
Weston, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Elizabeth Drake, Library Director, the Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality issues and health concerns at the Weston Public Library (the library) in Weston, MA. On November 28, 2001, a visit was made to this building by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program, BEHA, to conduct an indoor air quality assessment. John Niland, Head of Maintenance for the library, accompanied Mr. Holmes during the assessment. This request was prompted by reports of poor air circulation and general indoor air quality complaints.

The library is a one-story red brick and steel frame structure built in 1995 (see Cover). The library consists of the circulation desk, reading areas, periodical section, employee break room, boiler room/basement, children's library and a number of small private reading rooms located along the perimeter of study areas. Most windows in the building are unopenable. Occupants expressed interest in the possibility of installing additional openable windows to facilitate the introduction of outside air.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI Q-Trak, IAQ Monitor, Model 8551.

Results

The library has an employee population of approximately 7-10 individuals and can have 50-100 visitors daily. Tests were taken under normal operating conditions and results appear in Tables 1-3. Air samples are listed in the tables by location that the sample was taken.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million parts of air (ppm) in all areas surveyed, which indicates adequate air exchange. The MDPH approach to resolving indoor air quality problems in schools and public buildings is generally two-fold: 1) improving ventilation to dilute and remove environmental pollutants and 2) reducing or eliminating exposure opportunities from materials that may be adversely affecting indoor air quality.

A heating, ventilating and air conditioning (HVAC) system, consisting of three air handling units (AHUs), provides ventilation through ducted wall or ceiling vents (see Picture 1). Air is returned to the AHUs by wall and/or ceiling-mounted grilles (see Picture 2) via ductwork. This system was operating throughout the building on the day of the assessment. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy.

In order to have proper ventilation with a mechanical ventilation system, the system must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum mechanical ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (BOCA, 1993; SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open

windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation.

Temperature readings on the day of the assessment ranged from 70^{o} F to 75 ^{o} F, which were within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants.

A number of complaints of uneven heating and cooling were expressed to BEHA staff, specifically excess heat in the computer room and reports of extreme cold in the Library Director's office. Also noted was a thermostat near the children's library circulation desk mounted on a support column in close proximity to a computer monitor

(see Picture 3). Heated air rising from operation of the computer would activate the thermostat, which would in turn activate the HVAC system to provide cold air to this area during summer months. In winter, the HVAC system would be deactivated by heated air from the computer interacting with the sensors in the thermostat. The location of the thermostat can make it difficult for the ventilation system to control temperature in this area. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Relative humidity measurements ranged from 37 to 44 percent, which were within or slightly below the BEHA recommended comfort range in all areas sampled. The BEHA recommends that indoor air relative humidity be maintained in a range of 40 to 60 percent. Library staff reported that measurements above 80 percent relative humidity are experienced in the community room during the cooling season. No visible microbial growth and/or associated odors were noted during the BEHA assessment, nor any obvious point sources of moisture. A space was noted underneath the exterior door from which light could be seen penetrating (see Picture 4). Although this space can provide a pathway for outside moisture to enter the building during periods of high relative humidity, it is not likely the cause of the condition reported. Since this phenomenon occurs during the cooling season, it is most likely a problem associated with the air conditioning system. Building maintenance personnel stated that the library's HVAC system is under contract with an HVAC engineering firm and that they were working in conjunction with them to resolve the problem.

While temperature is mainly a comfort issue, relative humidity in excess of 70 percent can provide an environment for mold and fungal growth (ASHRAE, 1989). Since this area is fully carpeted, prolonged periods of relative humidity over 70 percent can create conditions conducive to mold growth. The American Conference of Governmental Industrial

Hygienists (ACGIH) recommends that porous building materials (e.g., carpeting, wallboard, ceiling tiles) be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed.

Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several areas had water-damaged walls and/or ceiling tiles (see Picture 5), which are evidence of roof or plumbing leaks. Water-damaged ceiling tiles can provide a source of microbial growth and should be replaced after a water leak is repaired. It was reported by Ms. Drake and Mr. Niland that the building has had a history of roof leaks due to incompatible building materials and that the roof had recently been replaced. Building staff were awaiting a wind-driven rainstorm in order to determine if leaks were repaired prior to replacing ceiling tiles.

Water damaged wallboard was noted in the children's area, reportedly as the result of a frozen roof drain (see Picture 6). To prevent this contingency, a heating element was wired into the drainage system. As stated previously if porous building materials become wet repeatedly, they can provide a medium for microbial growth.

Water fountains were noted installed over carpeted areas (see Picture 7). Spills or overflow from usage can result in wetting of the carpet, which can lead to mold growth.

Other Concerns

As discussed, some areas had missing/damaged ceiling tiles; fiberglass insulation in the ceiling plenum was exposed in the storytelling area (see Picture 8). Missing ceiling tiles can provide a pathway for the movement of odors, fumes, dusts and vapors into occupied areas and should be replaced after work is completed. In addition, fiberglass particles can be an eye, skin and respiratory irritant and should be contained.

Dirt and dust accumulation was noted on the return vent in the circulation workroom (see Picture 9). Aerosolized dirt and dust can provide a source of eye and respiratory irritation to certain individuals. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

Conclusions/Recommendations

In view of the findings at the time of this visit, the following recommendations are made:

1. Once roof repairs have been confirmed, replace all water-damaged ceiling tiles and wallboard. Inspect above and behind these areas for microbial growth and disinfect with an appropriate antimicrobial where necessary.
2. Continue to work with HVAC engineering firm to resolve relative humidity issues in the community room. Heating, cooling and general ventilation complaints should be communicated with the HVAC engineer in order to establish corrective actions for improvement of airflow and temperature control.
3. Consider having the HVAC system balanced every five years by an HVAC engineering firm in accordance with SMACNA guidelines (SMACNA, 1994).
4. Re-calibrate and/or replace thermostats as necessary to maintain control of comfort.
5. Relocate computer away from thermostat in children's library.

6. Consider installing additional openable windows to facilitate the introduction of outside air.

7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

8. Seal space beneath door in community room with weather stripping and a door sweep to prevent drafts and/or water penetration.

9. Install a water impermeable barrier (e.g., plastic or rubber) beneath water fountains to prevent water damage and potential microbial growth in carpeted areas.

10. Continue to work with roofing contractor to identify and repair any existing water leaks and replace any remaining water-stained building materials. Examine above and around these areas for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.

11. Clean return/exhaust vents periodically to prevent the accumulation of dirt and dust.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

ASHRAE. 1989. ASHRAE Standard: Ventilation for Acceptable Indoor Air Quality. Sections 5.11, 5.12. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Atlanta, GA.

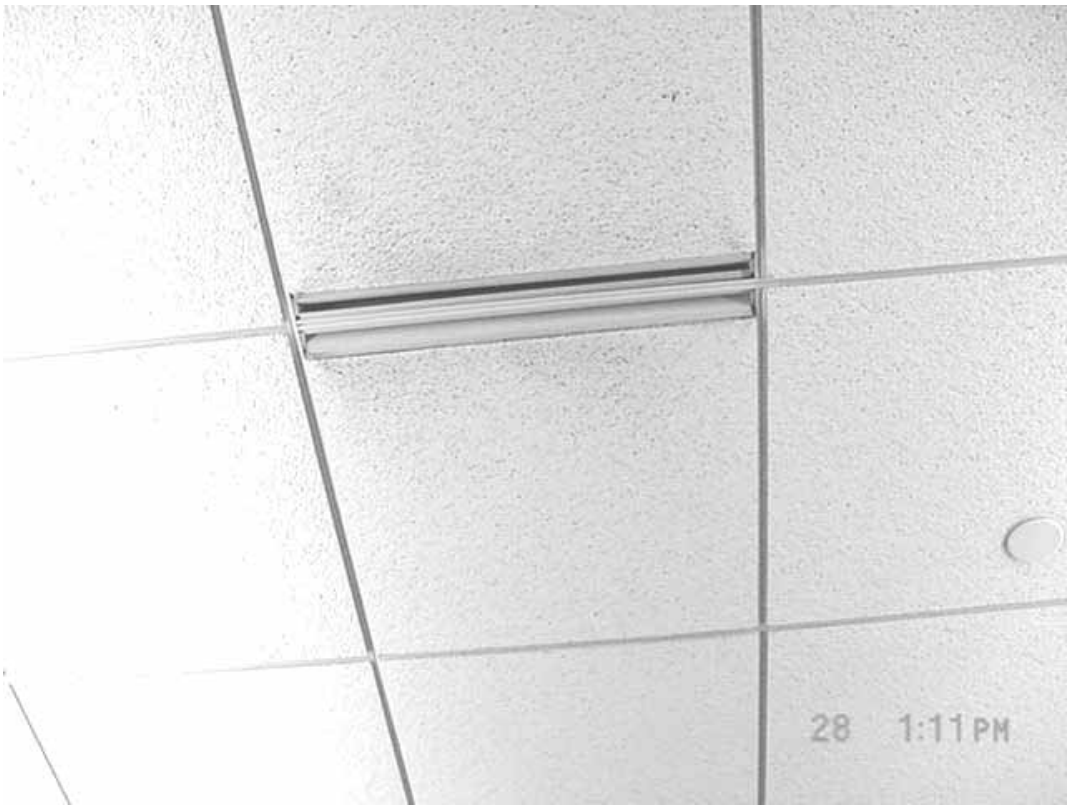
BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

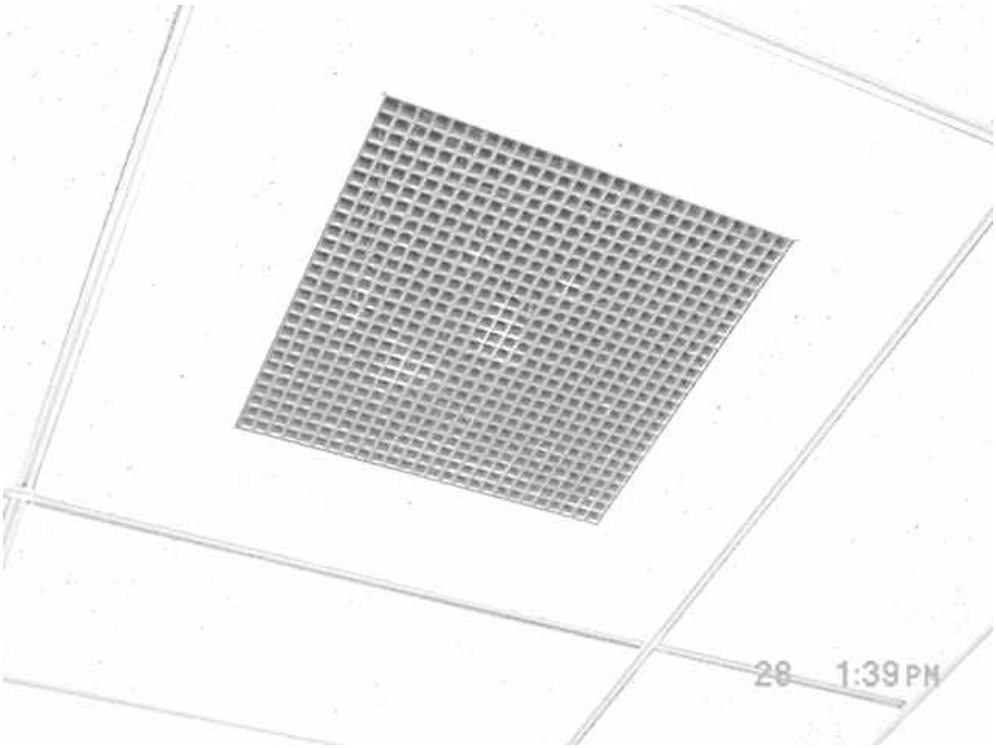
SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Picture 1



Slotted Ceiling-Mounted Supply Vent

Picture 2

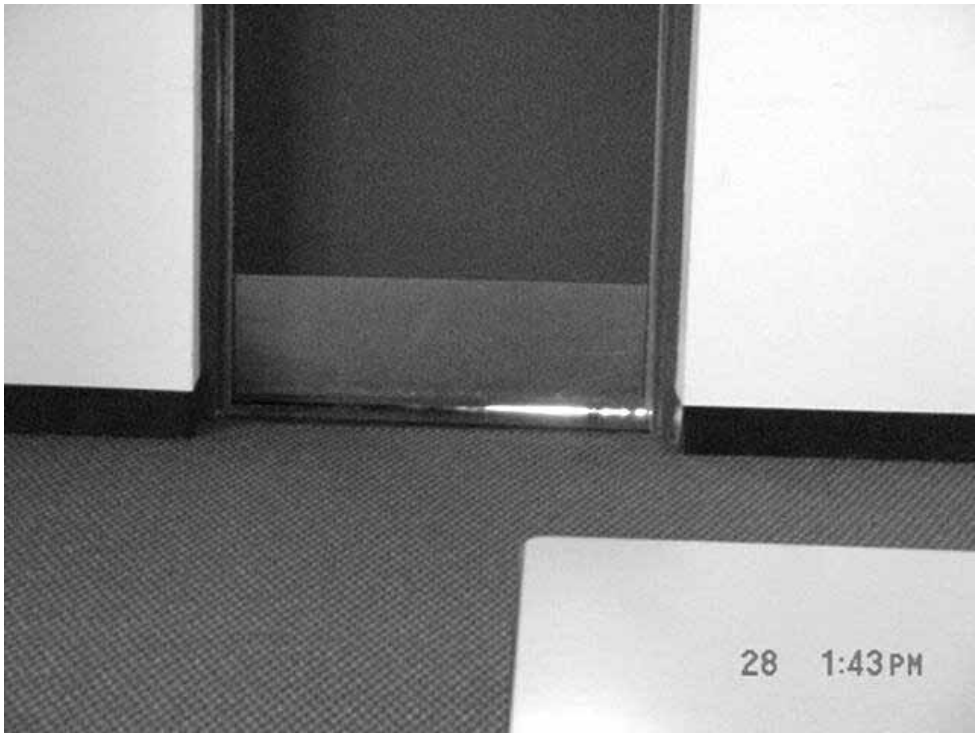


Ceiling-Mounted Return Grate

Picture 3

Computer Station in Close Proximity to Wall-Mounted Thermostat in Children's Library

Picture 4



Light Penetrating through Space Beneath Community Room Door

Picture 5

Water-Damaged Ceiling Tiles

Picture 6

Water-Damaged Wallboard in Children's Library

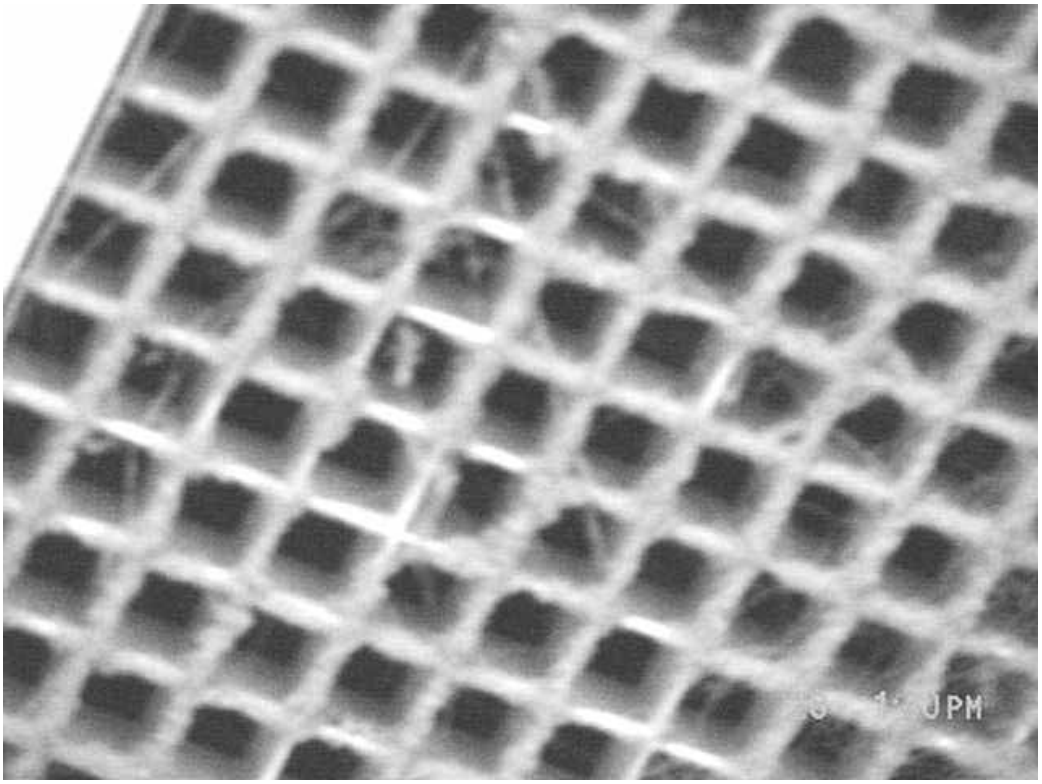
Picture 7

Water Fountains Installed over Carpeting

Picture 8

Exposed Fiberglass in Children's Library

Picture 9



Accumulation of Cobwebs and Dust on Ceiling-Mounted Return Vent

TABLE 1

Indoor Air Test Results – Weston Public Library, Weston, MA – November 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	381	66	46					Weather conditions: sunshine, light breeze
Library Director's Office	646	70	44	3	Yes	Yes	Yes	Temperature complaints – extremes/cold
Study Booth Area	520	72	41	1	Yes	Yes	Yes	
Computer Room	446	72	40	0	No	Yes	Yes	7 computers, heat complaints
Reference Library Office	450	72	38	0	Yes	Yes	Yes	
Main Foyer (west)	467	73	39	4	No	Yes	Yes	
Magazine/Journal Area	495	73	38	2	No	Yes	Yes	Plant (1), water stained CT (1)
Reading Room	425	71	38	0	Yes	Yes	Yes	Upholstered furniture, water-damaged CT (2)
Conference Room	424	70	38	0	No	Yes	Yes	Dry erase board
Adult Stack Area	499	71	40	3	Yes	Yes	Yes	Water-damaged CT (4)
Circulation Workroom	527	73	40	4	No	Yes	Yes	Dirt/dust/cobweb accumulation on return vent, dry erase board

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Weston Public Library, Weston, MA – November 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Circulation Desk	523	73	40	4	No	Yes	Yes	
Community Room	472	73	39	0	No	Yes	Yes	Water-damaged CT (10+), space under door-light, reports of humidity >80% during A/C season
Kitchen	444	73	38	0	No	Yes	Yes	
Women's Restroom			37	0	No	Yes	Yes	
Children's Area	457	75	37	4	No	Yes	Yes	Water-damaged wallboard from frozen drain - corrected
Children's Circulation Desk	455	74	37	5	No	Yes	Yes	Reports of stuffiness/stale air
Children's Area (north)	493	73	38	7	No	Yes	Yes	Numerous water-damaged/broken CT, missing CT, exposed fiberglass in northeast corner
Storytelling Area	458	74	37	0	No	Yes	Yes	
Study Room	612	73	38	1	No	No	Yes	
Local History Room	401	73	37	1	Yes	Yes	Yes	

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Weston Public Library, Weston, MA – November 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Cafeteria	489	73	37	1	Yes	Yes	Yes	
Business Office	497	73	37	1	Yes	Yes	Yes	1 missing CT

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%